CNTT-E-146

BASIC ELECTRICITY AND ELECTRONICS

STUDENT HANDOUT

NO. 309

SUMMARY PROGRESS CHECK AND JOB PROGRAM FOR MODULE 32-2

JUNE 1984

SUMMARY
LESSON 2

RC Phase Shift Oscillator

When you previously studied LC oscillators you learned how the LC tank circuit and amplifier accomplish a 360 degree phase shift. You also learned that the purpose of this phase shift was to provide regenerative feedback for the oscillator circuit. Recall that the purpose of regenerative feedback is to compensate for internal power losses within the circuit and that without this feedback, the circuit will stop oscillating.

Other methods besides an LC tank circuit may be used in order to provide phase shifting. One such method for accomplishing the phase shift is to use a series of RC networks. Remember that an RC network is made up of a resistor and capacitor. Also, recall that the ICE rule of thumb states that the current through a capacitor leads the voltage across it by 90 degrees. This means that a capacitor can cause a 90 degree phase shift. In actual application, however, this amount of shift cannot be realized. This is due to the fact that a resistance is required in the circuit in order to produce an output voltage. Therefore, when a capacitor is combined with the resistance the maximum possible phase shift of the voltage across the resistor may approach 90 degrees but cannot equal it.

If you do not remember how phase shifting is accomplished by using an RC network, refer to lesson 2 of module 12. Since one phase shift network cannot accomplish a 90 degree phase shift, it is necessary to use three or more networks in order to achieve the necessary 180 degree shift. A minimum of three RC networks is generally used. The schematic diagram shown in Figure 1 depicts a 3-section RC phase shift network.

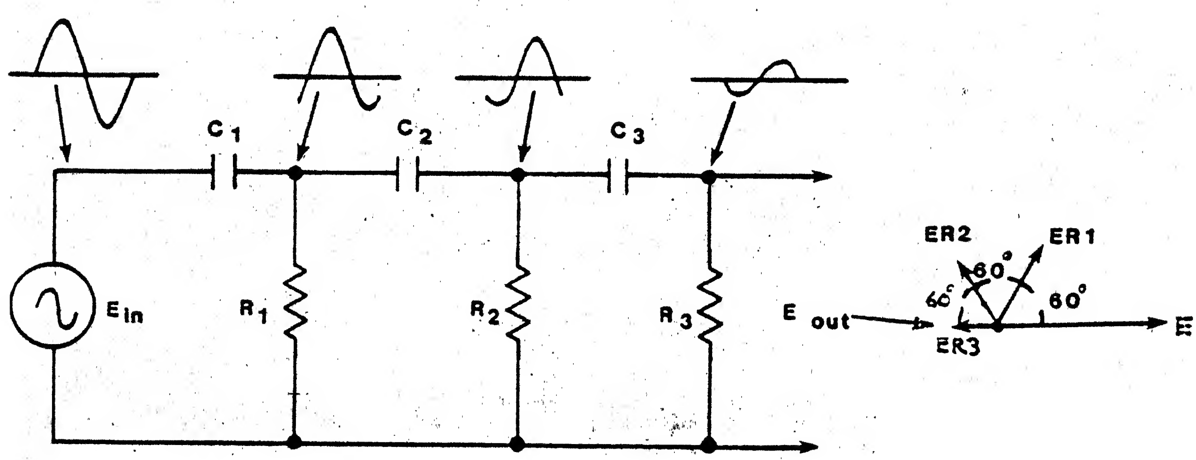
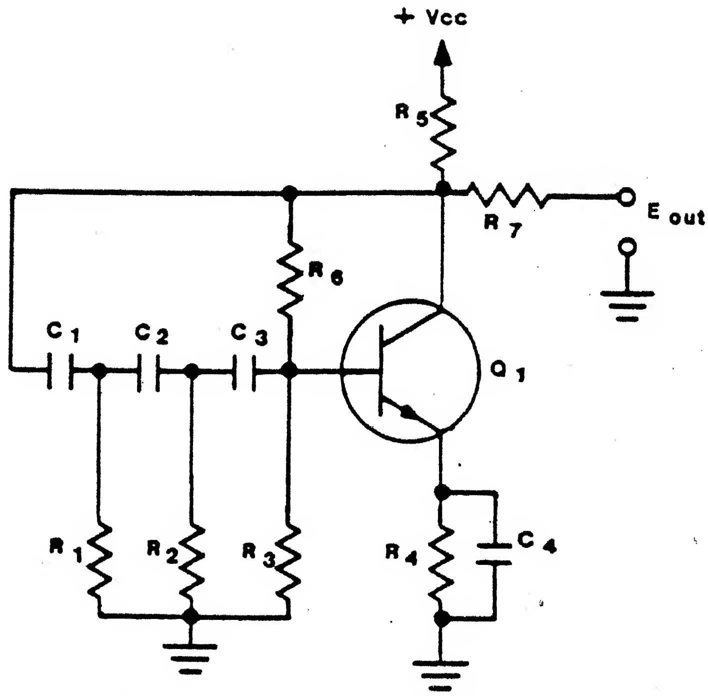


Figure 1

3-SECTION RC PHASE SHIFT NETWORK

For ease in understanding, each of the networks shown in Figure 1 shows a 60 degree phase shift. In actual practice, each of the RC networks will accompish phase shifts that are in the vicinity of 60 degrees. You may encounter a phase shift network of this type, where two of the networks effect a 75 degree phase shift and third network provides the additional 30 degrees of shifting. The most important thing for you to remember in regard to this is that the three networks combined accomplish the 180 degree shift. In addition to the schematic diagram, waveforms are shown immediately above each of the RC networks. These waveforms are used to illustrate the concept that the amplitude and phase of the input voltage is modified by each of the RC networks. The waveforms show that the amplitude decreases with each succeeding RC network. In addition to the waveforms, vectors are shown immediately to the right of the schematic diagram. These vectors also indicate the change of magnitude and phase shift provided by each RC network. Even though a 60 degree phase shift is indicated, remember, in actual practic the phase shift may be somewhat more or less than the 60 degrees shown. Alsc recall that the total shift must be 180 degrees. You will sometimes encounte four section networks, and these networks provide approximately 45 degrees of phase shift per network.

The schematic diagram shown in Figure 2 is that of an RC phase shift oscillator circuit.



$$f_o = \frac{1}{2\pi RC\sqrt{6}}$$

Figure 2

RC PHASE SHIFT OSCILLATOR CIRCUIT

The circuit shown accomplishes a 360 degree total phase shift from base, to collector, to base. The RC network accomplishes 180 degrees of the shift, whereas transistor Q1, in addition to amplifying the signal, contributes the other 180 degrees of phase shift. The amount of amplification provided by the transistor depends on the transistor's voltage gain.

The phase shifting network of the schematic shown in Figure 2 consists of resistors R1, R2, R3 and capacitors C1, C2 and C3. Although each RC section is capable of providing approximately 60 degrees of phase shift in actual practice, the phase shift provided by each of the networks may vary. Nevertheless, the three networks together provide a combined shift of 180 degrees. Components other than those which make up the RC network make up a standard common emitter type amplifier. Forward bias for the transistor is provided by the voltage divider from VCC to ground through resistors R3, R5, and R6. This resistance network establishes a voltage at the base of Q1 of about 0.6 volts positive in respect to the ground. In addition, a small amount of negative feedback is introduced by connecting R6 between the collector and base of Q1. This degenerative feedback improves the purity of the sinewave output signal. R5 functions as the collector load resistor for Q1, whereas the R4-C4 combination provides emitter stabilization action for the transistor. Resistor R7 couples a portion of the collector's signal of Q1 to the output terminals and isolates the oscillator from the load. Concerning this type of circuitry, it is possible to use either NPN or PNP transistors. The output of this oscillator circuit must be sufficient to provide a regenerative signal of adequate magnitude to compensate for internal power losses of the oscillator. As you undoubtedly know, if this is not provided, the oscillator will stop oscillating.

The output frequency of RC oscillators may be changed by changing the values of the resistors and capacitors which make up the individual RC networks. Increasing the resistance or capacitance of the components which make up the network results in a decrease in the output frequency. Conversely, a decrease in the resistance or capacitance of the network components results in an increase in the output frequency. This relationship is shown by the formula for the oscillating frequency.

The schematic diagram shown in Figure 3 is that of a variable frequency RC phase shift oscillator.

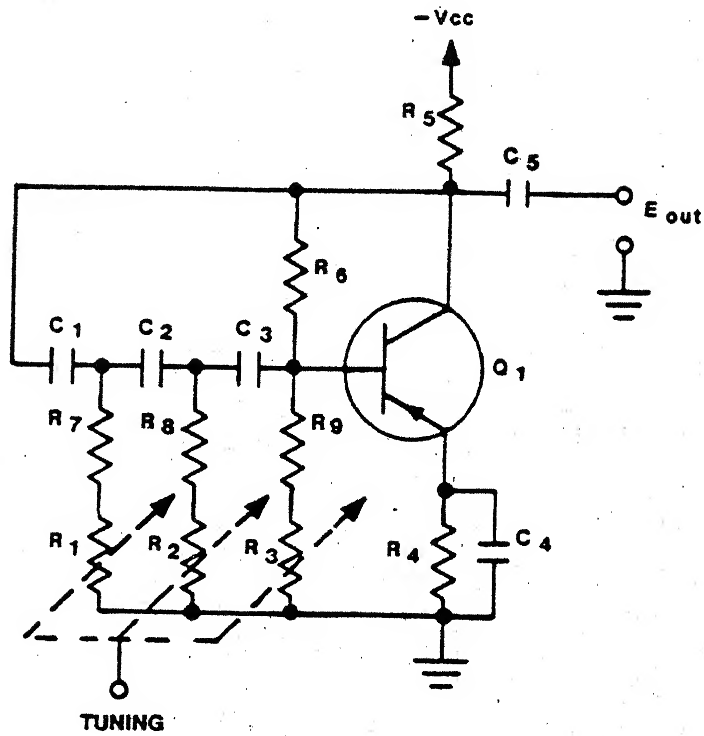


Figure 3

VARIABLE FREQUENCY RC PHASE-SHIFT OSCILLATOR

The addition of the ganged variable resistor allows the output frequency to be varied over a limited range. Notice that the variable resistors are part of the resistance of the phase shift network. Another technique which is sometimes used to vary the oscillator output frequency is to use ganged variable capacitors. Remember, the actual oscillating frequency of the oscillator may be determined by substituting in the formula: $F_o = \frac{1}{2\Pi RC\sqrt{6}}$ In this example the values of each of the RC networks is identical.

The oscillator circuit shown in Figure 3 provides a pure, nondistorted sinusoidal output waveform. Because there is no LC tank circuit to smooth the sine wave output, the oscillator must be operated in Class A service on the linear operating region for the transistor.

You will have an opportunity to work with an RC oscillator type circuit when you use the NIDA oscillator as part of your job program for this lesson.

AT THIS POINT YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE JOB PROGRAM. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER. PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF, INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), ON CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON 2

RC Phase Shift Oscillator

1. One purpose of an LC tank and RC network is to cause ______ phase shift.

   a. 60 degrees
   b. 120 degrees
   c. 180 degrees
   d. 360 degrees

2. To sustain oscillation, the feedback of an oscillator circuit must be

   a. neutral.
   b. degenerative.
   c. regenerative.
   d. compounded.

3. Oscillator feedback is required to

   a. compensate for internal circuit power losses.
   b. provide damping for the oscillator.
   c. provide a forward bias for the transistors.
   d. compensate for circuit overloads.

4. The theoretical maximum amount of phase shift possible with a single RC network is almost

   a. 60 degrees.
   b. 90 degrees.
   c. 180 degrees.
   d. 360 degrees.

5. In order to cause a 180 degree phase shift, a practical minimum of ______ RC networks is needed.

   a. two
   b. three
   c. four
   d. five

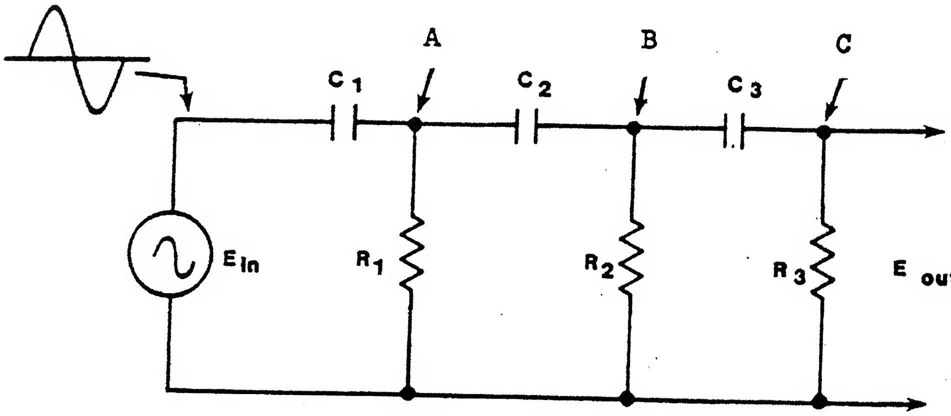
6. When series-connected RC networks are used to effect a phase shift, the total shift is the ______________ of the individual network phase shifts.

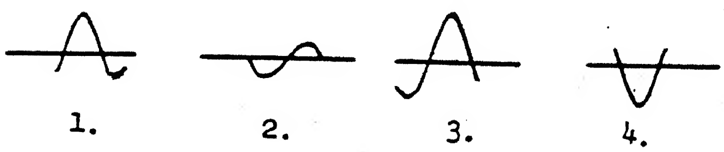
   a. product
   b. difference
   c. square
   d. sum

7. The phase shift of an individual RC network depends on the ____________.

   a. values of R and C.
   b. reactance of R.
   c. resistance of C.
   d. amplitude of input signal.

REFER TO THE SCHEMATIC SHOWN BELOW WHEN ANSWERING QUESTIONS 8, 9 AND 10.





8. With the input waveform shown, the output waveform is

   a. 1
   b. 2
   c. 3
   d. 4

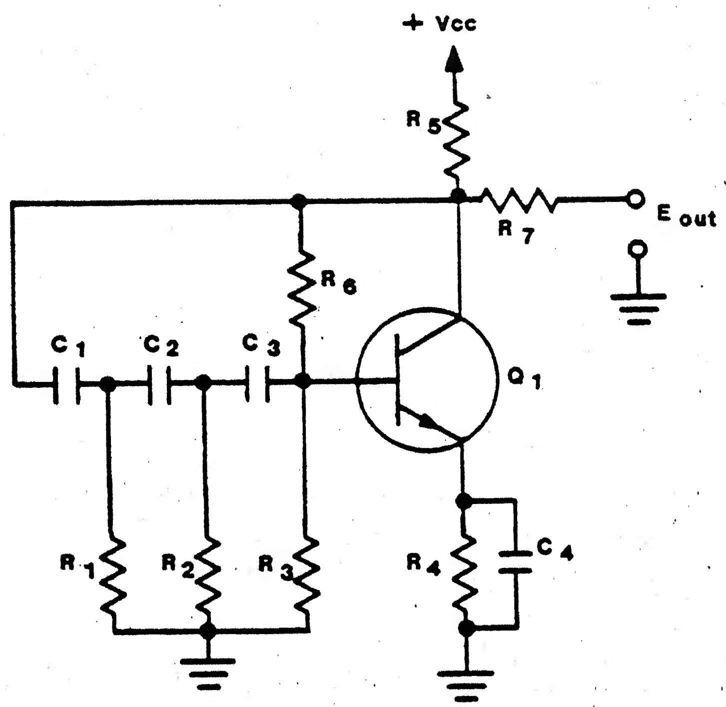
9. The signal at point A is represented by the waveform shown by

   a. 1
   b. 2
   c. 3
   d. 4

10. When the value of C2 is doubled, the output frequency

    a. increases.
    b. decreases.
    c. doubles.
    d. stays the same.

REFER TO THE SCHEMATIC SHOWN BELOW WHEN ANSWERING QUESTIONS 11, 12 AND 13.



11. The phase shift of each of the RC networks is theoretically about

    a. 45 degrees.
    b. 60 degrees.
    c. 90 degrees.
    d. 135 degrees.

12. The phase shift provided by transistor Q1 is

    a. 60 degrees.
    b. 90 degrees.
    c. 135 degrees.
    d. 180 degrees.

13. What type of feedback is provided through the RC network to the base of Q1?

    a. neutral
    b. degenerative
    c. regenerative
    d. 60 degrees out of phase

14. The output frequency of an RC phase shift oscillator may be increased by ________________ the value of the resistors.

    a. averaging
    b. decreasing
    c. increasing
    d. squaring

15. RC phase shift oscillators provide a stable fixed frequency sine-wave output signal in the __________ to ________________ range.

    a. 15 Hz to 200 kHz
    b. 300 kHz to 700 kHz
    c. 800 kHz to 1.5 MHz
    d. 1000 MHz to ∞

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE JOB PROGRAM. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

JOB PROGRAM
FOR
LESSON II

RC Phase Shift Oscillator

SAFETY PRECAUTIONS:

Observe all standard safety precautions. Beware of all exposed connections. An energized circuit may have dangerous voltages present.

EQUIPMENT REQUIRED

1. NIDA 203 Audio Oscillator
2. NIDA 203-3 PCB-RC Phase Shift Oscillator
3. NIDA 207 Oscilloscope
4. AN/USM-207 Frequency Counter
5. BNC-BNC Cables (2)
6. 1X Probe (1)
7. BNC "TEE" Connector (1)
8. Schematic Diagram of the RC Phase Shift Oscillator

DO NOT USE A DMM FOR MEASURING PN JUNCTION RESISTANCE. NORMALLY A DMM DOES NOT HAVE SUFFICIENT VOLTAGE TO FORWARD BIAS A TRANSISTOR JUNCTION.

PROCEDURES

1. Energize and set up the oscilloscope for dual trace operation with the trigger source switch set to the "EXT" position.

2. Connect the "TEE" connector to the trigger source input jack, connect a BNC cable from the output of the Audio Oscillator to one end of the "TEE" connector. Connect the second BNC cable from the "TEE" connector to the Channel 1 input of the oscilloscope. This procedure will synchronize the scope and at the same time, permit viewing of the output waveform from the Phase Shift Oscillator on trace "1".

3. Connect the 1X probe to the Channel 2 input of the oscilloscope.

4. Remove the top cover from the NIDA 203 Audio Oscillator.

5. Insert PCB 203-3 into the NIDA 203 Oscillator chassis.

6. Plug in and energize the NIDA 203 Audio Oscillator. A signal should appear on the Channel 1 line of the oscilloscope. It it does not, turn the AMPLITUDE control slightly CW.

7. Set the TIME/DIV switch on the oscilloscope to .5 msec.

8. Connect the 1X probe to pin #7 of the PCB. Notice that the output from pin #7 is 180 degrees out of phase with the output from the Audio Oscillator. This is because the signal is shifted 180° by an amplifier in the Audio Oscillator before it reaches the output jack on the front panel.

9. Make the following calculations of the waveform shown on the Channel 2 sweep.

   a. Calculate the amplitude of the waveform ________________ V p-p.

   b. Calculate the period of one cycle of the output waveform msec.

   c. Calculate the output frequency ________________ Hz.

10. Plug in and energize the AN/USM-207 Frequency Counter. Allow a minimum of 5 minutes for warm up time.

11. Set the TIME BASE switch to 10^5.

12. Set the FUNCTION switch to its maximum CCW position.

13. Set the B MULTIPLIER switch to position "3" and the com-sep switch to sep

14. Disconnect the Audio Oscillator cable from the "TEE" connector and connect it to the "B" AC input jack on the counter. This connection permits "period measurement" of the oscillator frequency. Remove the probe from pin #7 since this probe causes inaccurate readings on the frequency counter through the scope.

15. On the Audio Oscillator, turn the amplitude control fully CW.

16. Turn the AN/USM-207 power on switch to "STORE".

17. Turn the "B" TRIGGER VOLTS control until a reading appears on the frequency counter. Allow sufficient time for the reading to stabilize.

NOTE: This is a very sensitive control. If you turn it too far CW the frequency counter will indicate zero because you are overdriving the counter. If you do not turn it far enough the counter will indicate zero because the signal is not of sufficient amplitude to start the count. The gate lamp will be your guide. If the lamp starts to flash on and off a reading should appear on the counter. Manipulate this control to prove this to yourself.

a. What is the period of the input waveform? __________ msec.

b. Does this agree with step #9b above? __________ yes/no.

18. Set the TIME BASE switch to the "1" position.

19. Set the FUNCTION switch to the FREQ position.

20 Remove the BNC connector from the "B" AC input jack and connect it to the "C" AC input jack.

21. Set the "C" MULTIPLIER switch to position "3".

22. Set the SENSITIVITY switch to the "FREQ C" position.

23. Turn the "C" TRIGGER VOLTS control until a reading appears on the frequency counter. Refer to the NOTE in step #17.

a. What is the frequency of the input waveform? __________ Hz.

b. Does this agree with step #9c above __________ yes/no.

24. Place the AN/USM-207 frequency counter into standby. Remove the BNC connector from the "C" AC input and connect it to the "TEE" connector on the oscilloscope.

25. Manipulate the VOLTS/DIV controls and the VARIABLE VOLTS/DIV controls on channel #1 and channel #2 for equal amplitude signals with the 1X probe connected between R4 and R7. Notice that these two waveforms are 180° out of phase.

NOTE: Remember again that the reference waveform is applied to channel #1 and that the amplitude and phase of this waveform will not change. The waveform you wish to observe is applied to channel #2 and this is the waveform you must expect to change in amplitude and in phase.

26. Using the channel #1 and channel #2 vertical position controls combine the two waveforms into a single waveform.

27. Connect the 1X probe to the junction of C3 and R6.

    a. What has happened to the amplitude? ___________.

    Notice that the voltage applied to channel #2 is leading the reference voltage by 120 degrees.

28. Connect the 1X probe to the junction of C2 and R5.

    a. What has happened to the amplitude? ___________.

29. Change the channel #2 VOLTS/DIV control to increase the amplitude.

    Notice that the voltage applied to channel #2 is leading the reference voltage by 60 degrees.

30. Connect the 1X probe to the junction of C1 and R2.

    a. What has happened to the amplitude? _________.

    Notice that the voltage applied to channel #2 is almost in phase with the reference voltage and is the regenerative feedback necessary to keep the circuit oscillating.

You have now completed the Job Program for Module Thirty Two, Lesson 2. You have seen the operation of the RC Phase Shift Oscillator, calculated and measured the output frequency. If you do not understand any part of this Job Program it is suggested that you go through the parts that you do not understand.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON TEST. IF YOUR RESPONSES DO NOT AGREE, OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS, OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOUR RESPONSES DO AGREE.

FAULT ANALYSIS

(PAPER TROUBLESHOOTING)

FOR

MODULE 32, LESSON II

NOW THAT YOU HAVE COMPLETED THE KNOWLEDGE SECTION OF THIS LESSON, YOU ARE READY FOR PAPER TROUBLESHOOTING.

THE COMPUTER WILL ASSIGN YOU A SET OF PAPER TROUBLESHOOTING PROBLEMS ON RC PHASE-SHIFT OSCILLATOR. THESE PROBLEMS WILL HELP YOU DEVELOP THE MENTAL SKILLS REQUIRED IN ACTUAL TROUBLESHOOTING. YOU WILL BE GIVEN SYMPTOMS OF A FAILURE AND CIRCUIT MEASUREMENTS THAT WILL ALLOW YOU TO IDENTIFY THE PROBLEM.

AFTER YOU COMPLETE THE PAPER TROUBLESHOOTING SECTION, THE COMPUTER WILL ASSIGN YOU A PRACTICE TROUBLESHOOTING PROBLEM ON A FAULTY PRINTED CIRCUIT BOARD.

REMEMBER THAT REFERENCE VOLTAGES, WAVEFORMS, AND A SCHEMATIC ARE CONTAINED IN THIS STUDENT GUIDE FOR YOUR USE IN BOTH PAPER AND ACTUAL TROUBLESHOOTING PROBLEMS.

INFORMATION SHEET
FOR
TROUBLESHOOTING PERFORMANCE TEST

INTRODUCTION

Using the following six step troubleshooting procedures will aid you in determining which component is faulty. In the split method of trouble-shooting, the collector of Q1 has been selected as the starting point for this performance test. Based on your interpretation of the scope presentation at this point, you can determine which direction you should go.

EQUIPMENT

1. NIDA 203 Audio Oscillator Trainer
2. NIDA PCB 203-3 Phase Shift Oscillator
3. NIDA 207 Oscilloscope
4. Simpson 260 Multimeter and Test Leads
5. BNC-BNC Cables (2 short)
6. 1X Probe
7. TEE Connector (1)

INSTRUCTIONS

1. Each student is required to determine the defective component in a pre-faulted Phase Shift Oscillator. Your six step troubleshooting sheet must indicate that you used accurate test measurements and a logical procedure to find the faulty component.

2. Standard test equipment will be available to you in the form of an oscilloscope and a Simpson 260 multimeter. You will be expected to observe all safety precautions throughout the test. A safety violation will result in an automatic failure of the performance test. In that event you will be counselled and given remedial training.

3. You will take a numbered position in the test room. After briefing by the Learning Center Instructor you will fill out the heading of the trouble-shooting form. On a signal from the Learning Center Instructer you will then start the test. If at any time during the test you should require assistance, raise your hand. DO NOT LEAVE YOUR POSITION. A Learning Center Instructor will assist you with your trouble. If the trouble is due to no fault of your own, you will not be penalized and a time extention will be given if necessary You will set up the equipment according to the specifications given in the Job Program.

4. You must identify the faulty component to pass this performance test.

5. If you do not understand these instructions, raise your hand and ask your Learning Center Instructor. If you do understand these instructions, on a signal from your Learning Center Instructor you may now begin the Performance Test on the next page.

TROUBLESHOOTING PERFORMANCE TEST

DIRECTIONS: DO NOT WRITE IN THE PERFORMANCE TEST BOOKLET. MAKE ALL YOUR RESPONSES ON THE SIX STEP TROUBLESHOOTING SHEET SUPPLIED WITH THIS TEST PACKET. THIS PERFORMANCE TEST BOOKLET IS DESIGNED TO AID YOU IN COMPLETING THE STANDARD SIX STEP TROUBLESHOOTING FORM. COMPLETE THE STEPS USING YOUR KNOWLEDGE AND SKILL OF THE CIRCUIT SHOWN. CONTACT YOUR LEARNING CENTER INSTRUCTOR IF YOU HAVE ANY QUESTIONS.

SET UP THE EQUIPMENT AS YOU WERE INSTRUCTED IN THE JOB PROGRAM. CONNECT THE "TEE" CONNECTOR TO THE TRIGGER SOURCE ON THE OSCILLOSCOPE. CONNECT ONE BNC CABLE FROM THE OUTPUT OF THE PHASE SHIFT OSCILLATOR AND ONE END OF THE "TEE" CONNECTOR. CONNECT THE SECOND BNC CABLE FROM THE "TEE" CONNECTOR TO THE CHANNEL #1 INPUT OF THE OSCILLOSCOPE. CONNECT THE PROBE TO THE CHANNEL #2 INPUT OF THE SCOPE. ALL VOLTAGES AND WAVEFORMS WILL BE MADE WITH REFERENCE TO GROUND UNLESS THE PCB IS REMOVED TO MEASURE FRONT TO BACK RESISTANCE RATIOS OR TO MEASURE THE RESISTANCE OF A SPECIFIC RESISTOR.

STEP ONE - SYMPTOM RECOGNITION

1. Does the equipment energize? ______________ yes/no

STEP TWO - SYMPTOM ELABORATION

1. NO METERS. Proceed to step #3.

STEP THREE - LIST THE PROBABLE FAULTY FUNCTION(S)

1. There is only one function, the RC Phase Shift Oscillator. Proceed to Step #4.

STEP FOUR - LOCALIZE THE FAULTY FUNCTION

1. RC Phase Shift Oscillator.
2. Verify the faulty function by use of test equipment.
3. List the test points where voltages were obtained.
4. Reference voltages and waveforms are listed in the voltage/waveform chart.
5. Be sure you list the reference voltage/waveform on the troubleshooting sheet for each measurement you make.

TROUBLESHOOTING PERFORMANCE TEST

STEP FIVE - LOCALIZE THE FAULTY CIRCUIT/COMPONENT

1. List the test points where actual voltages were taken.
2. What circuit/component in the faulty function listed in step four is faulty?
3. If you have determined the faulty circuit but not the faulty component proceed to part four.
4. Secure the power and using the Simpson 260 take resistance measurements.
   a. Check front to back ratios on the transistor.
   b. Continuity checks on printed circuit board foil.
   c. Capacitors can be shorted or open.
   d. Resistors can be open.

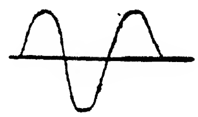
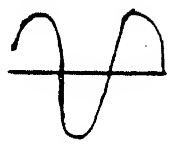
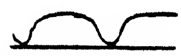
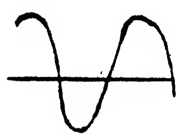
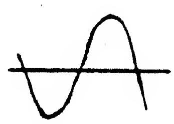
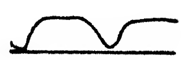
STEP SIX - FAILURE ANALYSIS

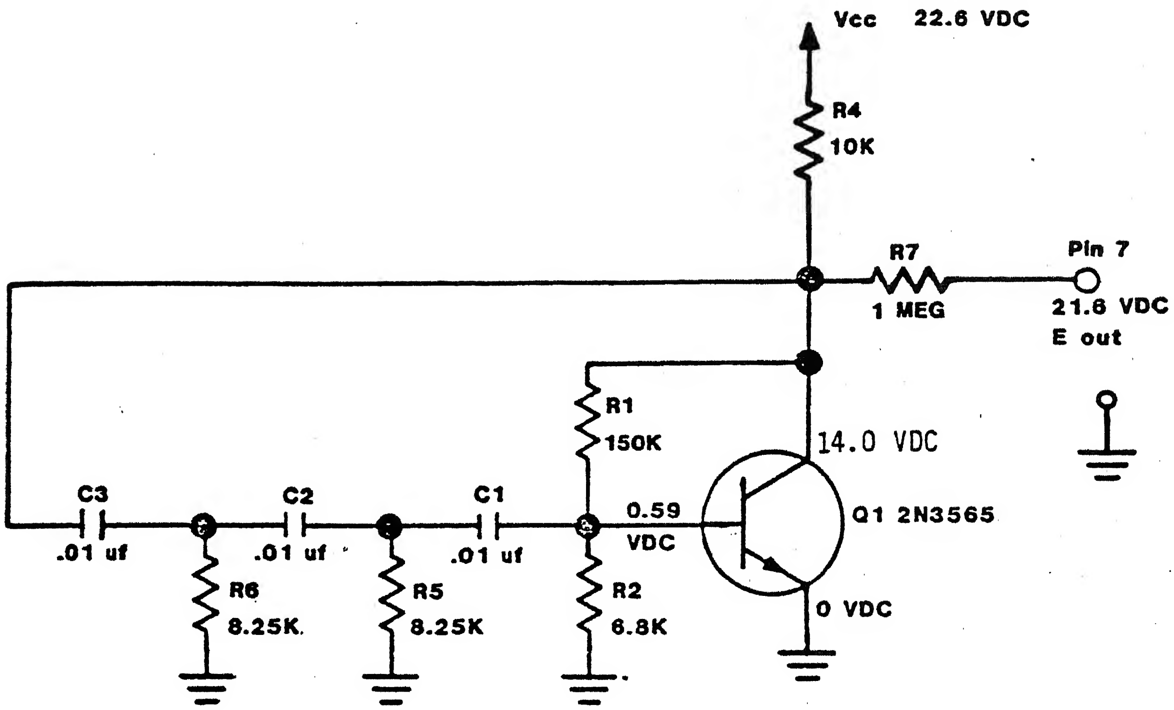
Explain in your own words why the component listed in steps five or six above would cause the symptoms listed in steps one and two of the six step troubleshooting procedure? Write your answer in the space provided on the troubleshooting form.

TAKE YOUR SIX STEP TROUBLESHOOTING SHEET TO YOUR LEARNING CENTER INSTRUCTOR FOR VERIFICATION AND EVALUATION.

VOLTAGE/RESISTANCE/WAVEFORM CHART

The following Voltages, Resistances and Waveforms were taken with a Simpson 260 multimeter and an Oscilloscope with the 1X probe connected to the channel #2 input. All Voltages, Resistances, and Waveforms were taken with respect to ground or circuit common.

Point of Check	Voltage	Resistance	Waveforms	
Pin #7	20 VDC	860 K ohms		0.190 V P/P
V_C Q1	17 VDC	220 K ohms		4 V P/P
V_B Q1	0.55 VDC	930 ohms		0.045 V P/P
Pin #6	21.7 VDC	240 K ohms		0.01 V P/P
Junction R6 & C3	0 VDC	8.5 K ohms		1.45 V P/P
Junction R5 & C2	0 VDC	8.5 K ohms		0.5 V P/P
Junction R2 & C1	0.55 VDC	930 ohms		0.045 V P/P



RC PHASE SHIFT OSCILLATOR

P.P. 22

ANSWER SHEET FOR

PROGRESS CHECK

LESSON 2

RC Phase Shift Oscillator

QUESTION No.	CORRECT ANSWER
1.	c.
2.	c.
3.	a.
4.	b.
5.	b.
6.	d.
7.	a.
8.	b.
9.	a.
10.	b.
11.	b.
12.	d.
13.	c.
14.	b.
15.	a.

ANSWER SHEET
FOR
JOB PROGRAM
LESSON 2

RC Phase Shift Oscillator

9a. 0.190 Vp-p
b. 1.15 msec.
c. 869 Hz.

17a. 1.15 msec.
b. yes

23a. 867 Hz.
b. yes

27 . Decreased

28a. Decreased

30a. Decreased

☆ U.S. GOVERNMENT PRINTING OFFICE: 1984—785-178